TESTING FOR A CONTRACTIONAL ORIGIN OF JANICULUM DORSA ON THE NORTHERN, LEADING HEMISPHERE OF SATURN'S MOON DIONE. C. B. Beddingfield[1], J. P. Emery[1], D. M. Burr[1], [1]Earth and Planetary Sciences Department, University of Tennessee, Knoxville, TN, USA (cbeddin1@utk.edu).

Introduction: Dione, a ~1,100-km-diameter satellite orbiting at a distance of 377,000 km (6.3 Saturn radii) from Saturn, has a surface composed of H_2O ice with minor abundances of volatile CO_2 and CN [1]. The surface consists of densely cratered terrain and wispy terrain [2]. The wispy terrain, centered on Dione's northern trailing hemisphere, is interpreted as consisting of several sets of extensional fractures, horsts, and graben [3].

In Dione's northern, leading hemisphere, a set of features with a common trend is present. These features include a large, prominent ridge, Janiculum Dorsa [4,5], and at least four large troughs (Figure 1). The ridge stands 1-2 km above the surrounding densely cratered terrain for most of its length [4]. To our knowledge, an origin for these features – whether formed through extensional or contractional tectonics -- has not been previously investigated.

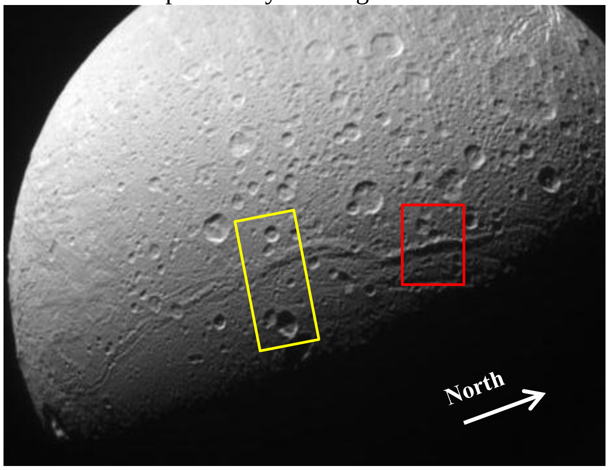

Figure 1: A large prominent ridge, Janiculum Dorsa, on Dione's northern, leading hemisphere. The locations of DEM 1 (red) and DEM 2 (yellow) are shown.

Background: Normal faults typically break at ~60° angles to the surface, resulting in ~60° scarp dips [6], although tilting or erosion of normal fault blocks would reduce this dip angle. Because normal faults break at ~60° to the surface, the resulting change in slope between the surface and the fault scarp should be ~60° consistently along strike. This value holds true for both tilted and non-tilted fault blocks, although erosion may still decrease the observed value. In contrast, thrust faults typically break at ~30° angles to the surface and their scarps are not typically exposed.

In an extensional setting, overlying pre-existing craters should be offset and extended. This type of deformation would result in craters that appear to be elongated perpendicular to the fault system trend. Conversely, in a contractional setting, overlying and pre-existing craters may be offset and shortened. This type of deformation results in craters that appear to be elongated parallel to the trend of the contractional system. If the contractional feature is in the form of a blind thrust fault or a fold, then none of the craters would be offset and shortening of the craters will be minimal.

Hypotheses and Tests: In this work we test for both contractional and extensional origins for Janiculum Dorsa. Because Janiculum Dorsa appears to be similar in plan view morphology to lobate scarps on Mercury [7], our preferred hypothesis is that Janiculum Dorsa is contractional. If the ridge formed from contraction, then it is likely the surface manifestation of a thrust fault, a blind thrust fault, a fold, or some combination of the three that varies along strike. The alternative hypothesis is that the ridge is extensional, in the form of a single or multiple normal faults.

1. Prominent Slope Angle Test: Contractional features are expected to display lower prominent slope angles than extensional features. To account for possible tilting or erosion of a potential normal fault system, we lowered the prominent dip angle criterion for an extensional feature from 60° to 45°. By our accounting, slope angles smaller than 45° would support the hypothesis of contraction. Alternatively, the hypothesis for extension would be supported.

2. Slope Change Test: Contractional features are also expected to show smaller changes in slope than extensional features. To account for possible erosion of a potential normal fault, we also lowered the maximum slope change criterion for an extensional feature from 60° to 45°. By our accounting, slope changes smaller than 45° would support the hypothesis of contraction. Alternatively, the hypothesis for extension would be supported.

3. Crater Strain Test: If any of the craters overlying Janiculum Dorsa have been shortened perpendicular to the trend of the ridge, as indicated by prominent crater rim trend directions parallel to the ridge, then the hypothesis for contraction would be supported. If none of the craters have been shortened nor extended, then the hypothesis for contraction would also be supported. If any overlying craters have been elongated perpendicular to the ridge, then the hypothesis for extension would be supported.

Data and Methods: Images from the Cassini Imaging Science Subsystem (ISS) were processed and projected using the Integrated Software for Imagers and Spectrometers (ISIS) [8] provided by the United States Geological Survey (USGS). Two digital elevation models (DEMs) (Figure 1) were created using overlapping image pairs (Table 1) with the Ames Stereo Pipeline software [9,10]. Measurements were taken using ESRI's ArcGIS software.

DEM Number	Center Lat. Lon.	Image Numbers
1	35° N, 209° E	N1643286422 N1665975432
2	14° N, 216° E	N1665975603 N1507741283

Table 1: The image numbers used to derive each DEM and their geographic locations are shown.

On these two DEMs, a total of 40 profile lines were created across Janiculum Dorsa. Several slope measurements and slope change measurements were taken across each profile line. Using ISS images N1507740822, N1665975432, and N1665975603, prominent crater trend direction measurements and ridge trend measurements were taken in four separate regions of the ridge. Statistical analyses of the distribution of the crater trend directions were done in each of the four sections and were compared to both random distributions and to the average feature trend in each of the areas to determine if either ridge perpendicular shortening or extension has taken place.

The amount of shortening / elongation that took place across the boundary can be found using the equation

$$\Delta L = L_0 - L_f \ ,$$

where L_f is the final width of the ridge, and L_0 is the initial width of the ridge. We determine L_f by measuring the distance across the ridge and L_0 by measuring the length of the topographic surface across the width of the ridge.

The percent strain that took place across Janiculum Dorsa in the locations of the two DEMs (extensional or contractional) can be calculated using the equation

$$\% \text{ strain} = \frac{L_0 - L_f}{L_0} \text{ x } 100 \ .$$

Results: For the region of Janiculum Dorsa covered by DEM 1, the average slope across the ridge and trough walls is 1.5° with a standard deviation of 0.5° and a maximum value of 12°. For the area covered by DEM 2, those values are 1.2°, 0.4° and 11°, respectively. These small slope values satisfy the test for a contractional feature.

For the region of Janiculum Dorsa covered by DEM 1, the average slope change value is 3.3° with a standard deviation of 1.1°. For the area covered by DEM 2, those values are 2.4° and 0.7°, respectively. These small slope change values also satisfy the test for a contractional feature.

The prominent crater trends in image N1507741283, and in the northern and southern section of N1665975432 are randomly distributed. The craters do not have statistically prominent trend directions, suggesting that these craters have not been shortened nor extended. The prominent crater trends in image N1665975603 are not randomly distributed, but a t-test shows that the crater trend direction is not statistically similar to the average trend of the ridge in this area. This interpretation means that the craters in this region have not been shortened or extended perpendicular to the trend of the ridge. This observation supports the hypothesis for contraction.

The results of all three tests better support the hypothesis that Janiculum Dorsa is contractional over the hypothesis that it is extensional. From measurements across each profile line, we calculated the amount of shortening across Janiculum Dorsa. An average of 55 m of shortening (standard deviation of 3 m) and 3.4% contraction (standard deviation of 0.2%) took place over the ridge covered in DEM 1. An average of 33 m of shortening (standard deviation of 2 m) and 3.0% contraction (standard deviation of 0.2%) took place over the ridge covered in DEM 2.

To our knowledge, Janiculum Dorsa is the first suggested contractional feature on Dione. The ridge parallels the margin of a regionally elevated region to the east and may be associated with its formation [4]. Additionally or alternatively, Janiculum Dorsa may have accommodated the extension that occurred in Dione's wispy terrain in the equatorial region [2]. Thus, future work may include estimating the amount of extension that took place within the fracture sets of the wispy terrain, and comparing that with the amount of shortening that took place in Dione's northern, leading hemisphere. Future work may also include conducting the same tests on the grooves that trend subparallel to the northern hemisphere ridge. If these features are also contractional, then a total amount of shortening in this region could be estimated.

References: [1] Clark et al. (2008) *Icarus, 193, 372-386.* [2] Moore (1984) *Icarus 59, 205-220.* [3] Wagner et al. (2006) *LPS XXXVII, 1905.* [4] Moore and Schenk (2007) *LPS XXXVIII, 2136*. [5] Wagner et al. (2009) *LPS XXXX, 2142*. [6] Anderson (1951) *The Dynamics of Faulting.* [7] Watters (1993) *JGR 98, 17049-17060.* [8] Anderson (2004) *LPS XXXV, 2039*. [9] Broxton et al. (2008) *LPS XXXVIIII, 2419.* [10] Moratto et al. (2010) *LPS XXXXI, 2364*.